Near-surface wind speed statistical distribution: comparison between ECMWF System 4 and ERA-Interim

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1. Background and goals

We have studied the **properties** of the statistical distributions of 10m wind speed from the **ERA-Interim** (Dee et al., 2011; ERA-Int) reanalysis and **ECMWF System 4** (Molteni et al., 2011; S4) seasonal forecast system. This is important to provide useful climate information in wind energy **decision-making** processes which use simple assumptions of the wind speed frequency distribution to estimate **wind energy potential**. Besides, this study also illustrates where the discrepancies of the distributions of the seasonal predictions and the reference dataset are higher and, thus, which might need special attention from a **bias correction** perspective.

2. Data and methods

The **differences** between the statistical distributions of 10m wind speed from the ERA-Int **reanalysis** and S4 seasonal **forecast system** have been assessed at global scale. We have focused on two seasons, **JJA** and **DJF**, considering both their **interannual** and **intraseasonal** variability for every forecast start date. The 10m wind speed distribution has been characterised in terms of the **four main moments** of the probability distribution (**mean**, **standard deviation**, **skewness** and **kurtosis**; Wilks, 2006). We have also computed the coefficient of variation to identify the regions with the higher wind variability and the **Shapiro-Wilks** goodness-of-fit test to assess their normality.

3. Results

Climatology

The climatologies represented by the ERA-Int reanalysis and S4 are **very close** to each other (Figure 1; 95% of the grid points have differences between **1** and **-1** m/s). The **S4** systematically **overestimates** wind speed at global scales. The geographical distribution makes us hypothesise that this overestimation might be related to how the model sees surface roughness.

Variability

The differences in the standard deviation are **rather small** (Figure 2; constrained to -0.5 and 0.5 m/s for 95% of the grid points). From an end-user perspective this is important because it means that the climatological variability of the **model** is **close** to the **reference** both **interannually** and **intraseasonally** and, also, for DJF and JJA. That said, the bigger differences are found in the inter-tropical areas and the intraseasonal frame.

Coefficient of variation

Concerning interanual/intraseasonal differences, we find much **higher** values in the **intraseasonal** maps than in their interannual counterparts. The disparity of values between ERA-Interim and S4 is **larger** in DJF than in JJA, and in the inter-tropical oceanic regions than over the continents (Figure 3). Besides, in DJF there is also a remarkable strip of land near 60ºN where S4 clearly underestimates wind speed variability. This seems to be also the case in the Amazonian, African and Indonesian rainforests (specially in DJF). In these regions one might hypothesise that vegetation plays a role in these differences.

Kurtosis and Skewness

The differences in **both** parameters are very **noisy** and do not follow clear patterns (not shown). What we can conclude from these results is that while the **S4** is able to approximately reproduce the structure of the first two moments of the distribution, it has much **more difficulty** in attaining the **third** and **fourth moment** patterns and so they deserve special attention from a bias correction point of view.

Shapiro-Wilks test

The **intertropical** areas and the **intraseasonal** time-scales **cannot** be regarded **normally** fitted (not shown). For the **extratropical**, this is only true at **intraseasonal** scales. However, the way in which this normality is violated is different depending on the season, the time scale and the dataset.

4. Conclusions

- There are **little differences** between the discrepancies computed among the different **forecast horizons** (only shown for climatology).
- In the **inter-tropics** and some **extra-tropical** regions, **normality** dependent **methods** should be **carefully applied**.
- **S4** is **capable** of reproducing the **first** and **second** statistical **moments**. With the **third** and **fourth** moments, though, it has **more difficulties**.
- We have located the **hot-spot regions** for the study of wind from a **bias adjustment** standpoint. Although they differ depending on the parameter considered, they are **generally centred** in the **intertropics** and some extratropical areas.

5. Acknowledgements

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6. References

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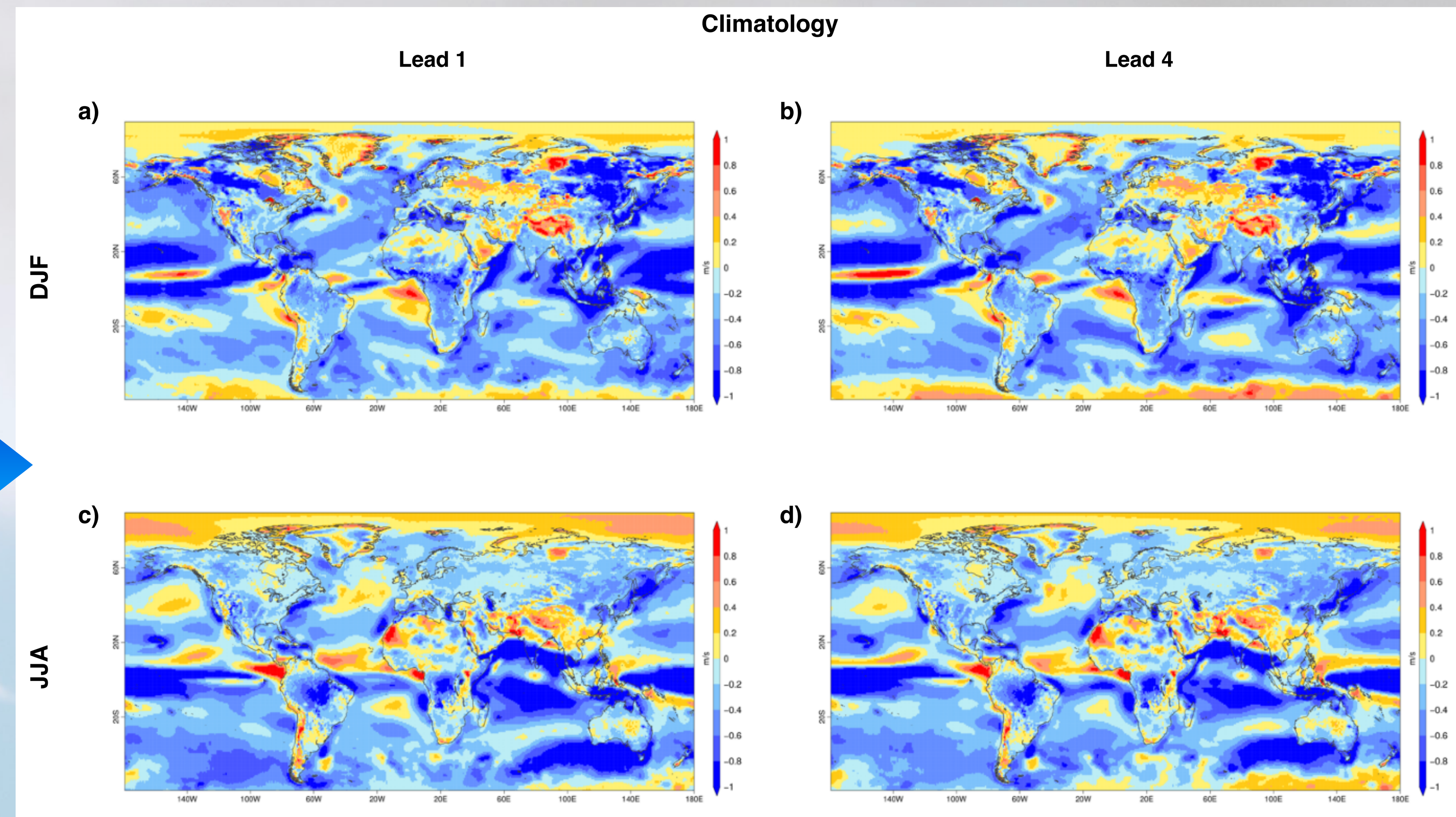

Figure 1. Climatology differences between ERA-Int and S4 10m wind speed forecasts, considering the period 1981-2015. a) DJF, lead 1, November start date b) DJF, lead 4, August start date c) JJA, lead 1, May start date d) JJA, lead 4, February start date.

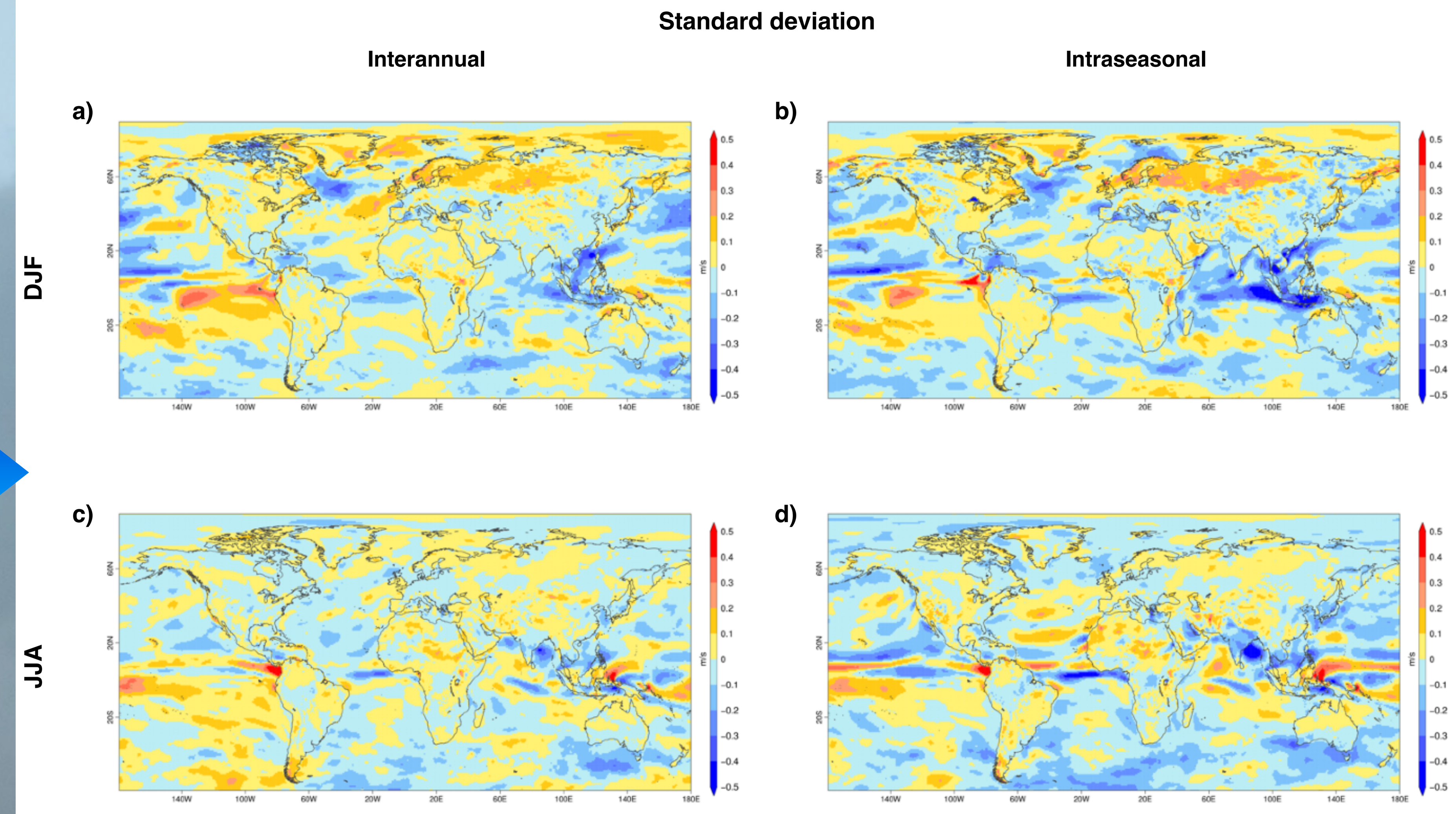

Figure 2. Standard deviation differences between ERA-Int and S4 10m wind speed forecasts (lead 1), considering the period 1981-2015. a) DJF, interannual b) DJF, intraseasonal c) JJA, interannual d) JJA, intraseasonal.

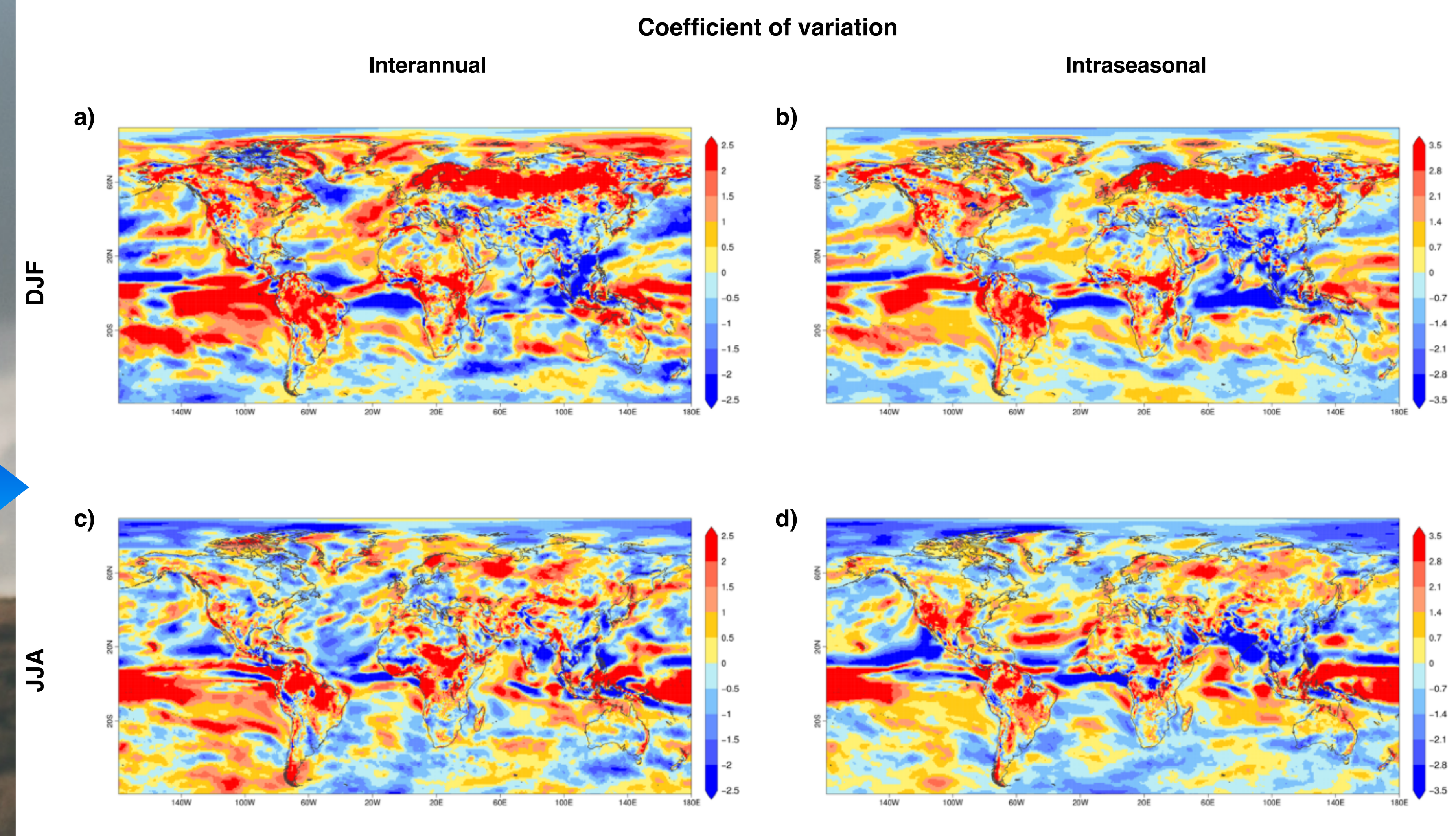

Figure 3. Coefficient of variation differences between ERA-Int and S4 10m wind speed forecasts (lead 1), considering the period 1981-2015. a) DJF, interannual b) DJF, intraseasonal c) JJA, interannual d) JJA, intraseasonal.